7.1.2 Resurvey Cross-Sections

"Survey cross-section locations using a tagline strung between the endpoints. Vertical measurements will be taken every ten feet and at topographic break points. The river portion will be surveyed using a small boat."

(In Progress)

7.1.3 Estimate Roughness Coefficient

"The roughness coefficient and bed material size will be estimated for representative cross-sections. "

(In Progress)

7.1.4 Estimate Bed Material Size

"The roughness coefficient and bed material size will be estimated for representative cross-sections. "

Table 28. Estimate of Roughness Coefficients

Feather River Geomorphic Study
Estimates of Roughness Coefficients (Manning's N)

USGS Cross-section Number	River Mile	Setting *	USGS ** estimated N (1972)	USACE *** estimated N (1997)
1		not noted	not noted	
2		left bank	0.030	
2		right bank	0.035	
3		left bank	0.030	
3		brush	0.070	
3		trees on right	0.060	
4		orchard on left	0.070	
4		channel	0.035	
5		channel	0.030	
5		orchard on right	0.040	
6		trees on left	0.070	
6		channel	0.030	
7		not noted	not noted	
8		not noted	not noted	
9		orchard on left	not noted	
9		channel	0.035	
10		left bank	0.045	
10		channel	0.045	
11		channel	0.035	
11		right bank	0.050	
12		not noted	not noted	
13		left channel	0.035	
13		low brush island	0.050	
13		right channel	0.033	
14		channel	0.035	
14		walnut orchard on righ	0.040	
15		left	0.050	
15		channel	0.035	
15		right	0.040	
16		channel	0.030	
16		right	0.050	
17		Gridley Bridge	not noted	
18		Old Gridley Bridge	not noted	
19		left bank	0.040	
19		channel	0.034	
20		channel	0.035	
21		left	0.045	
21		channel	0.040	
21		orchard on right	0.040	
22		channel	0.036	
22		orchard on right	0.040	
23		left channel	0.040	
23		island	0.045	
23		right channel	0.040	

Table 28. Estimate of Roughness Coefficients

	23		right bank	0.055		
	24		left	0.050		
	24		channel	0.035		
	24		right	0.040		
	25		road on left	0.040		
	25		orchard	0.065		
	25		channel	0.035		
	25		right	0.040		
	26		left	0.045		
	26		channel	0.035		
	26		orchard on right	0.042		
	27		left channel	0.040		
	27		right channel	0.040		
	27		right bank, trees	0.045		
	28		left	0.045		
	28		channel	0.040		
	28		right	0.045		
	29		channel	0.035		
	30		left	0.045		
	30		channel	0.035		
	31		left	0.045		
	31		channel	0.032		
	31		right	0.040		
	32		tailings and brush	0.065		
	32		channel	0.040		
	33		left	0.045		
	33		channel	0.035		
	33		right	0.060		
	33A		trees on left	0.045		
	33A		channel	0.032		
	33A		orchard on right	0.042		
	34		left	0.060		
	34		channel	0.035		
	35		channel	0.040		
	36		channel	0.045		
	37		channel	0.045		
	38		channel	0.045		
	39		channel	0.040		
	40		left	0.040		
	40		left channel	0.032		
	40		island	0.040		
	40		right channel	0.034		
	40		right island	0.045		
	41		left	0.045		
	41		left channel	0.032		
	41		island	0.045		
	41		right channel	0.032		
	41		right	0.045		
	42		left	0.050		
	42		channel	0.032		
	42		island	0.045		
	42		right channel	0.032		

Table 28. Estimate of Roughness Coefficients

	42		right	0.040		
	43		left	0.045		
	43		channel	0.036		
	43		right	0.040		
	44		left	0.038		
	44		channel	0.032		
	44		right	0.042		
	45		left	0.040		
	45		channel	0.032		
	45		right	0.040		
	46		left	0.042		
	46		channel	0.032		
	46		island	0.035		
	46		channel	0.040		
	47		left	0.040		
	47		channel	0.032		
	47		right	0.038		
	48		left	0.042		
	48		channel	0.032		
	49		left, ponded sloughs	0.050		
	49		overflow area	0.042		
	49		channel	0.032		
	50		left	0.036		
	50		island	0.045		
	50		channel	0.032		
	50		right	0.055		
	51		left	0.042		
	51		channel	0.032		
	51		right	0.055		
	52		left	0.045		
	52		channel	0.033		
	52		channel	0.038		
	53		left	0.045		
	53		channel	0.032		
	53		right	0.040		
	54		rock piles	0.040		
	54		channel	0.032		
	54		right	0.044		
	55		left	0.040		
	55		channel	0.030		
	55		right	0.044		
	56		left	0.045		
	56		channel	0.032		
	55		right	0.045		
	57		brush	0.045		
	57		borrow pit	0.035		
	57		bank	0.050		
	57		clean cobbles	0.030		
	57		sloping bank	0.040		
	58		Thermalito Bridge	not noted		
	59		not noted	not noted		
	60		not noted	.042 or .045		

Table 28. Estimate of Roughness Coefficients

60		river	0.032	
60		right bank	0.038	
61		left of river	0.034	
61		river	0.032	
62		not noted	not noted	
63		not noted	not noted	
64		not noted	not noted	
65		left bank	0.042	
65		river	0.030	
65		right bank	0.038	
66		left bank	0.038	
66		river	0.033	
66		right bank/hatchery	0.038	
67		Table Mtn. Rd. Bridge	not noted	
67.1		left bank	0.035	
67.1		river	0.030	
67.1		right bank	0.035	
68		Fish Barrier Dam	not noted	

*   left and right banks are defined from view looking downstream

** USGS *" Feather River Channel Characteristics"* (1971)

*** USACE "Floodplain Study" (1997)

7.1.5 Gravel Sampling

"Conduct gravel sampling at representative cross-sections and tabulate data."

7.1.6 Intergravel Permeability Measurements

"Conduct… intergravel permeability measurements at representative cross-sections and tabulate data."

7.2 ANALYSES

(In Progress)

8.0 MONITOR CROSS-SECTIONS AND SAMPLE SEDIMENTS

8.1 METHODOLOGY AND RESULTS

"Cross-section locations will be monitored for changes periodically. A representative number will be selected to measure hydraulic and sediment transport conditions at a variety of discharges. These measurements will be used to calibrate the sediment transport and geomorphic models used in another part of the study. The monitoring will consist of setting a tag line between the cross-section monuments; measuring the depth and stream velocity; measuring bedload transport using a Helley-Smith bedload sampler; monitoring bedload movement by using painted and radio tagged rocks, measuring temperature; measuring the hydraulic radius; and other stream parameters as necessary."

8.1.1 Locate Existing Cross-Sections

"Select representative number of cross-section locations for monitoring."

(In Progress)

(In Progress)

Figure 21. Proposed Representative Cross-sections for Monitoring, Lower Feather River from Lake Oroville to Honcut Creek

8.1.2 Measure Physical Characteristics

Habitat typing will be done with standard DFG protocols (Table 28).

(In Progress)

8.1.2.1 Channel Characteristics

"verification of inventory data from the Rosgen Level 1 survey;
alteration of channel morphology;
field evidence of change in alignment (lateral movement, avulsion);
observations of vertical instability (aggradation, degradation);
observations of changes in channel dimensions (width, depth);
excessive deposition of fine sediment;
presence of instream bars, observation of bar size and material;
type of depositional features associated with each channel type;
indicators of scour and erosion;
comparison with reference reaches;
project-related sediment starving;
project-related structural controls;
dependence on channel type; and
functionality of riparian habitat."

8.1.2.2 Bank Characteristics

"evaluation of bank stability;
identify bank stability characteristics by channel type, instability mechanism;
bank height and length;"

8.1.2.3 Sediment Characteristics

"length (along observed channel corridor) and estimated sediment volume;
type of sediment (size class based on visual observation);
approximate thickness of accumulations;"

8.1.2.4 Tributary Characteristics

*"descriptions of the features of tributary inputs;
presence/absence of active and/or remnant deltas at confluences with main stem;
sediment characteristics of tributary inputs: lithology, grain sizes, stratigraphy of deposits;"*

8.1.2.5 Vegetation Characteristics

*"presence of vegetation encroachment in the low-flow channel;
observed emergent and/or woody vegetation in low-flow, or bottom width channel;
geomorphic function of woody debris;
role in formation of habitat units;
role in bed or bank definition and stability;"*

(In Progress)

Table 29. Representative Field Survey Form for Habitat Characterization

8.1.3 Monitor Cross-Sections over a Range of Flows

"Conduct monitoring activities at representative low, medium, and high flows to cover the full spectrum of streamflow and sediment transport. including the evaluation of flow velocities for the initiation of bedload movement.

Measure temperature, depth, velocity, turbidity, bedload movement, and suspended sediment across the cross-section locations using standard U.S. Geological Survey methodology.

Prepare graphs, tables, and charts showing streamflow, temperature, turbidity, sediment discharge, bedload and suspended sediment size distribution."

(In Progress)

Table 30. Representative Cross-sections and Characteristics, Lower Feather river from Lake Oroville to Honcut Creek

8.2 ANALYSES

(In Progress)

9.0 PROJECT EFFECTS ON GEOMORPHIC/HYDRAULIC CHARACTERISTICS

" In this task, hydrologic analysis will be used to provide an indication of the project effects on geomorphically significant flows. Flood-frequency analysis, using hydrologic data presented in the Initial Information Package, will be applied to the Feather River to determine these flows. For alluvial systems, Andrews and Nankervis (1995) describe sediment transport and channel maintenance flows ranging between 0.8 and 1.6 times the bankfull discharge in gravel-bed rivers. For gravel-bed streams in the Rocky Mountain region, this study recommended that the channel maintenance flow be provided for an average of 15 days per year. This benchmark will be applied as an initial evaluation for river reaches with alluvial (sand or gravel beds) channels. This study (SP-G2) will also attempt to quantify riparian and valley-forming flows using the concepts as defined in Hill et al. (1991), as appropriate. Flood-frequency analysis will be used in conjunction with field indicators to determine bankfull flow. Methods in Hill et al. (1991) will be used to guide the assessment of the magnitude, timing, frequency, duration, and rate of change of out-of-channel flows.

Flow duration curves developed in SP-E2 and 3 will then be used to determine the timing and duration of geomorphically significant flows (indicated by the flood frequency analysis) in the project streams. The magnitude, timing, duration, frequency, and rate of change of flows will be described where gaging data is available. The data will be displayed graphically, and as exceedance tables. Comparison will be made between regulated and unregulated flows.

These data, taken together with the determination of geomorphically significant flows, will describe the effect of project operations on the occurrence of these flows. This will be done by comparing historic data with recent data. Available past cross-sectional data will be compared to those surveyed in Task 3 to determine changes in channel shape, form, and function caused by the dam. Changes in depth, width, hydraulic radius, roughness, gradient, pool-riffle-run ratio, and other hydraulic parameters will be determined.

Aerial photos and old survey maps will be used to establish the location of historic river channels. These will be used to establish the extents of the meander belt (if any). Geologic maps will be used with aerial photo interpretation to identify structural controls on river erosion and plan form.

9.1 METHODOLOGY AND RESULTS

9.1.1 IHA Analyses

Conduct IHA analyses to compare current and historic flow conditions. Describe and compare patterns of total annual precipitation and runoff. Delineate changes in base flows. Prepare graphs, tables, charts showing pre- and post dam changes in flood frequency, ramping rates, flow duration, mean monthly discharge, and others.

Ongoing project effects to stream flow will be studied by using historical hydrologic data. The "Indicators of Hydrologic Alteration" (IHA) model will be run using the existing impaired flow data compared to unimpaired flow. Impaired and unimpaired flood frequency, flow duration, and mean monthly flow graphs will be prepared to show the changes."

(In Progress)

9.1.2 Historic River Channels and Morphology

Collect existing survey, topographic, and photographic data. Plot channel locations for the years available on the atlas and the GIS. Delineate changes in channel location, islands, multiple channel areas, levees, and riprap. Determine ongoing impacts of the dam by comparing pre- and post dam bank erosion and channel migration rates, island and multiple channel formation rates, gravel bars, riffles, channel width, gradient, and other geomorphic characteristics. Prepare figures, graphs, and charts showing the changes.

Use Rosgen's Level I and Level II or higher stream classification systems to determine historic changes.

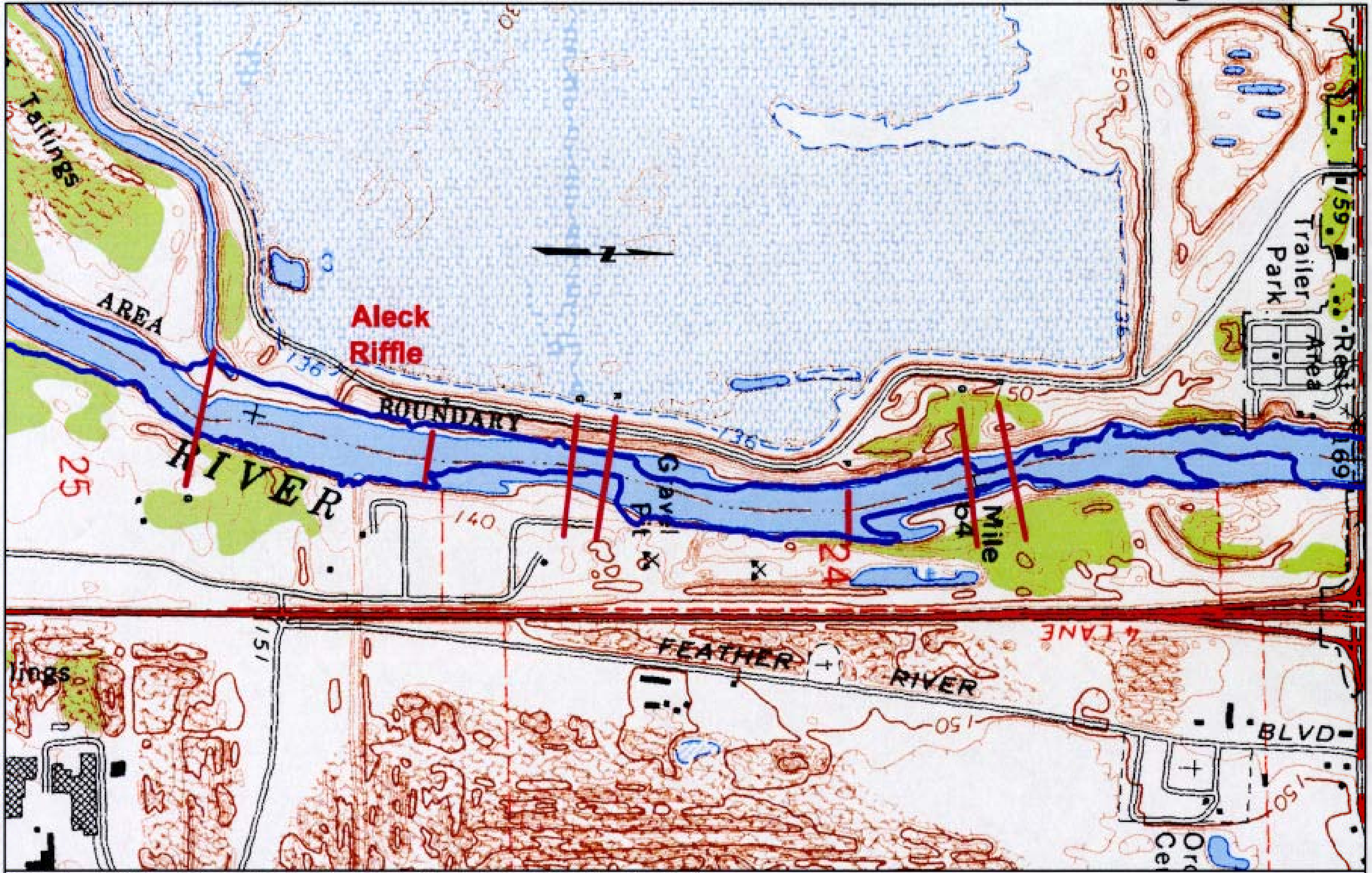
9.1.2.1 Historic River Channels

(In Progress)

9.1.2.2 Rosgen Classification

(In Progress)

Figure 22



SP-G2 GEOMORPHIC STUDY

Feather River Low Flow Reach, Aleck Riffle

1992/2003 IFIM Cross-Sections

Filename:N:\RAID1\Geo\PROJECTs\Feather River\0 - Interim Report\Meander 04-21-03 ca.dwg
Layout Name:Layout1 Plot Time: May 08, 2003 - 12:26pm

Oroville FERC Relicensing
(Project No. 2100)

9.1.3 Hydraulic Effects

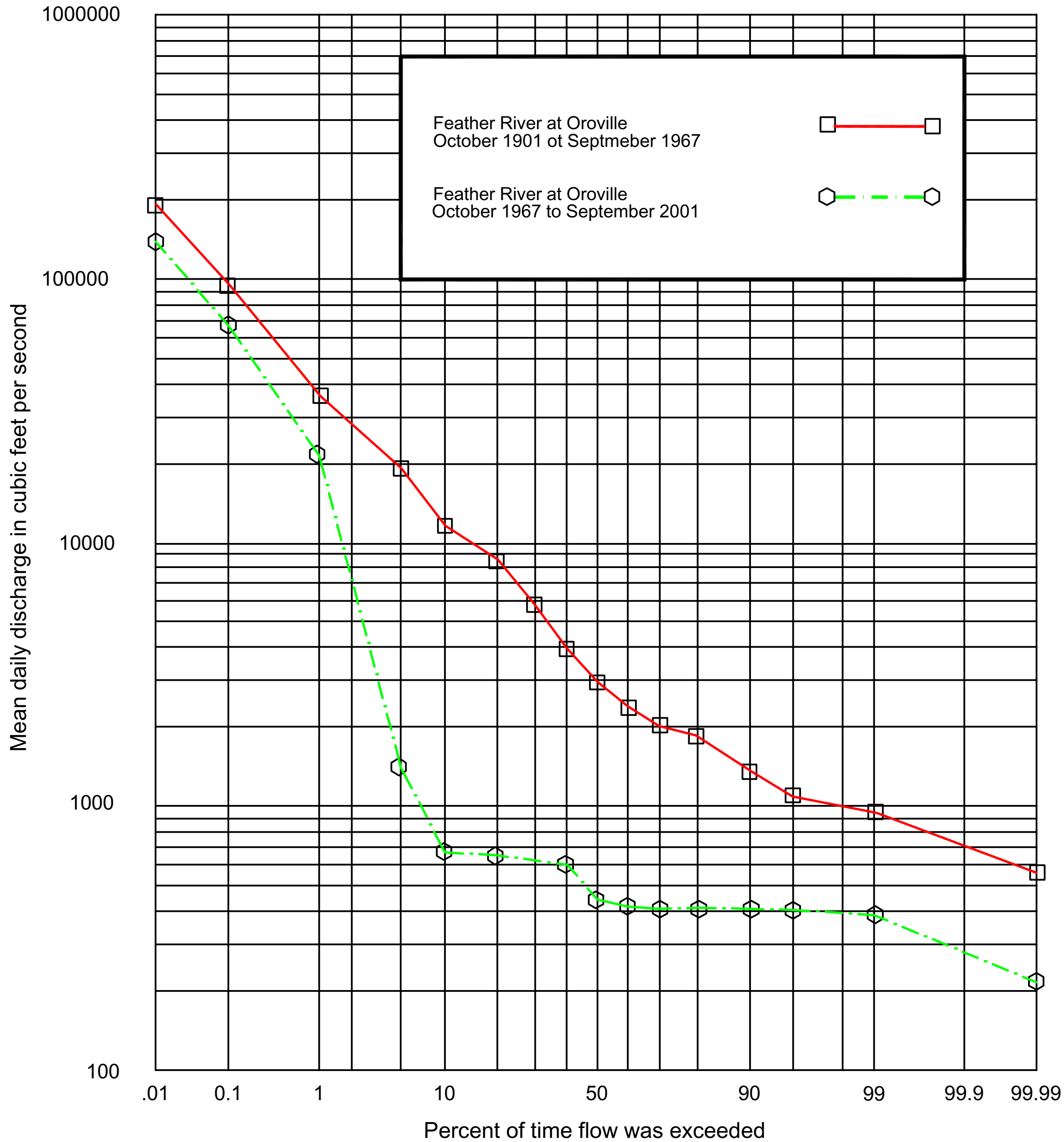
9.1.3.1 Flood Frequency

(In Progress)

9.1.3.2 Bankfull Discharge

(In Progress)

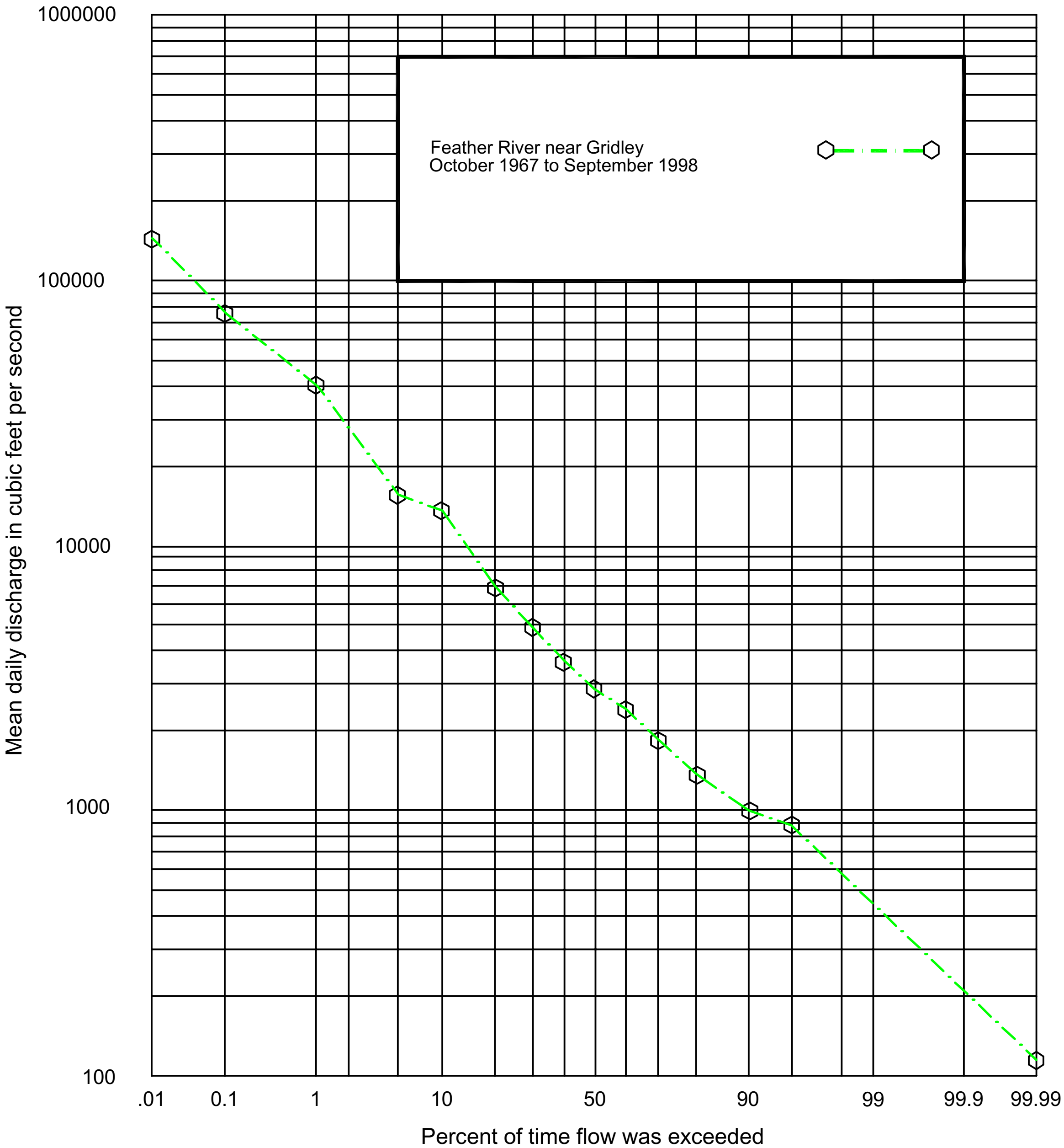
Figure 23



STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT

Oroville Facilities Relicencing
FERC Project No. 2100
Flow Exceedence
Feather River at Oroville

Figure 24



STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT

Oroville Facilities Relicencing
FERC Project No. 2100
Flow Exceedence
Feather River near Gridley

9.1.4 Geomorphic Effects

9.1.4.1 Changes in Longitudinal Profile

9.1.4.2 Cross-sectional Changes

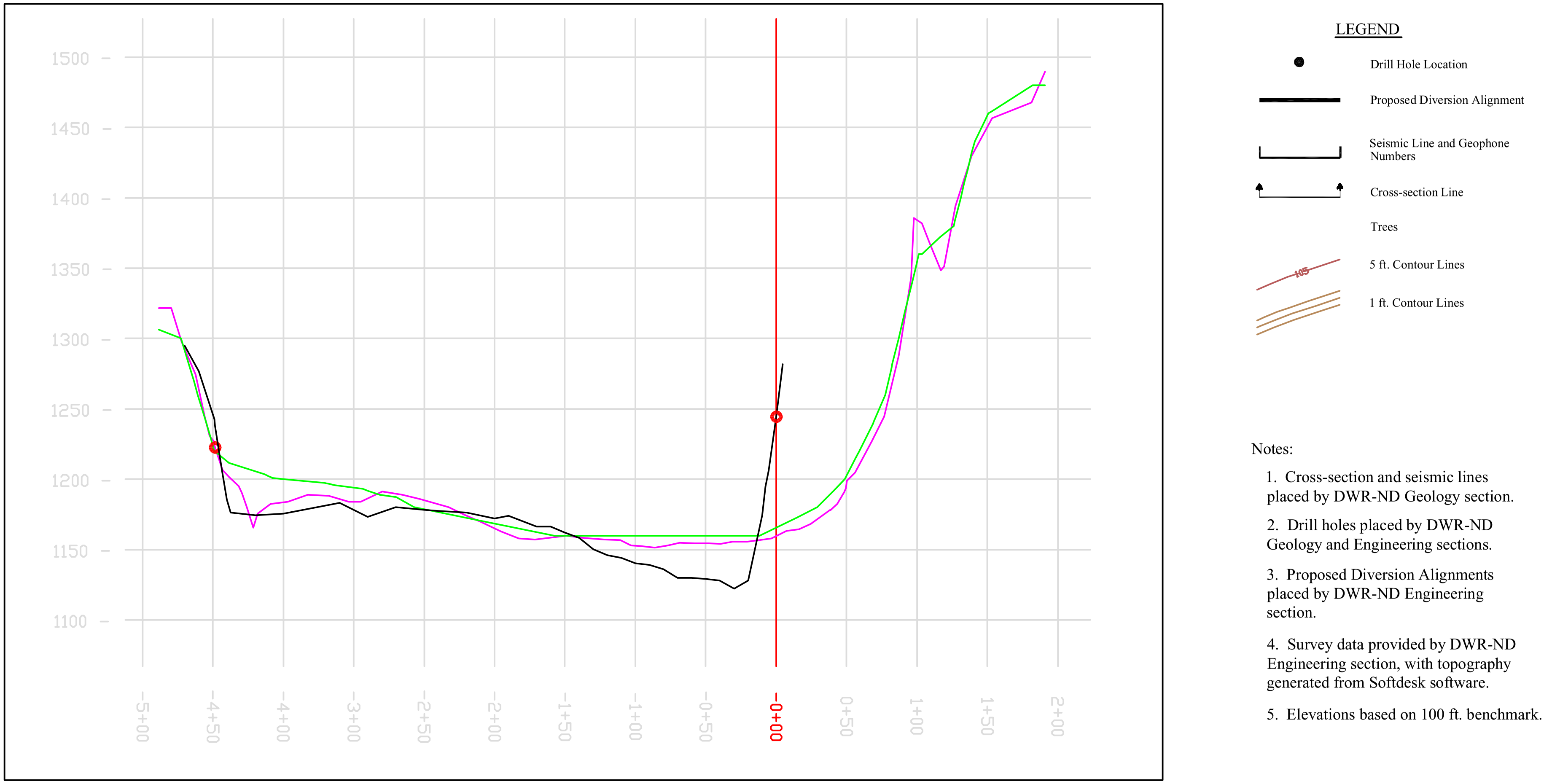
(In Progress)

9.1.4.3 Changes in Hydraulic Parameters

(In Progress)

(In Progress)

Figure 25. Lower Feather River, Historic Changes in Longitudinal Profile, Lake Oroville to Verona



Notes:

1. Cross-section and seismic lines placed by DWR-ND Geology section.
2. Drill holes placed by DWR-ND Geology and Engineering sections.
3. Proposed Diversion Alignments placed by DWR-ND Engineering section.
4. Survey data provided by DWR-ND Engineering section, with topography generated from Softdesk software.
5. Elevations based on 100 ft. benchmark.

REV.	DATE	DESCRIPTION

DRAWING SCALES

GEOLOGY REPORT No.
CONSTRUCTION SPEC. No.
GEOLOGY DRAWING No.

GEOLOGIC MAPPING BY:
1 GEOLOGIC MAPPING NOT DONE AT THIS TIME.
2
3
DRAWING MODIFIED FROM BASE MAP BY:
KELLY STATON DATD 12/29/98

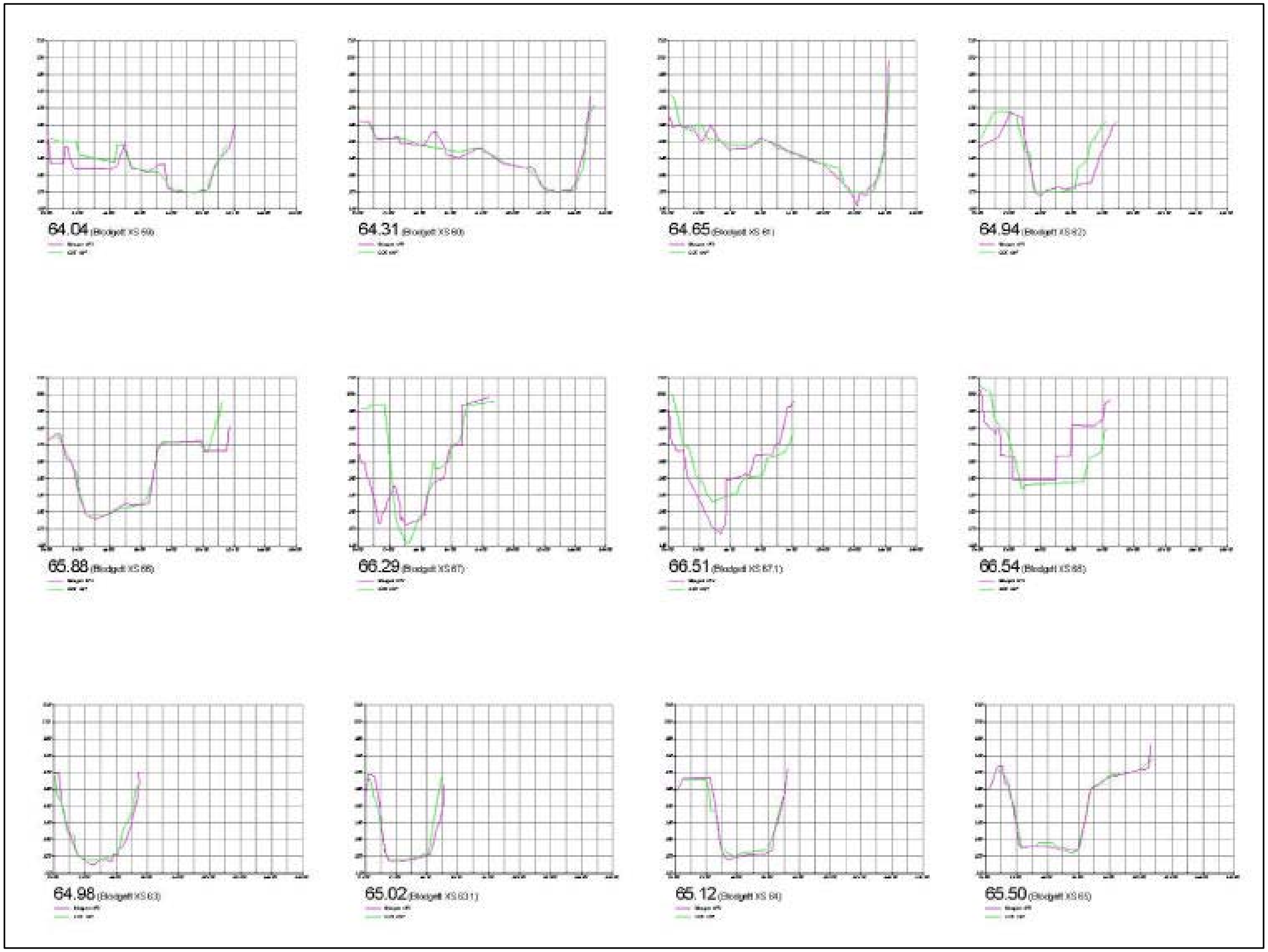
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF LOCAL ASSISTANCE
GEOLOGY SECTION

FIGURE 26. CHANGES IN HISTORICAL CROSS-SECTIONS
FEATHER RIVER
ALECK RIFFLE

RELEASE DATE :
SHEET No. 1
PLATE 1

mc_plt1.dwg

FIGURE 27



SP-G2 FEATHER RIVER GEOMORPHIC STUDY

Changes in Lower Feather River Channel

1971-1997

Filename:N:\RAID1\Geo\PROJECTs\Feather River\0 - Interim Report\Figures\Latest Numbered Figures\Figure 27 5-8-03 ca.dwg
Layout Name:Layout3-Layout1   Plot Time: May 19, 2003 - 4:13pm

Oroville FERC Relicensing
(Project No. 2100)

10.0 IDENTIFY AND MONITOR BANK EROSION SITES

10.1 METHODOLOGY AND RESULTS

"In areas where bank erosion is occurring, monitoring sites will be established to determine erosion rates and the nature of the material eroded). The eroding bank endpoints will be marked using steel pipe set in concrete monuments. Banks will be surveyed a minimum of twice yearly, once in the spring to determine amount of winter erosion, and once in the late fall to determine low flow erosion. The global positioning system technique will be used to determine bank location to the nearest 3 feet horizontally (plan view).

For all identified transects, detailed field measurements will include surveying the channel profile into the floodplain and abandoned floodplain (if present), identification of bankfull elevation, water surface slope, and the wetted perimeter at the time of measurement. Substrate material will also be documented (Wolman pebble count and laboratory grain size analysis), and bank slope would be recorded for alluvial sections. An assessment of out-of-channel flow requirements for riparian vegetation/floodplain landforms will be completed at approved transect locations. In addition, measurement of channel dimensions, indicators of sediment accumulation (V or other sediment accumulation indicator), quantitative analysis of flows required to initiate motion (Shields criterion), and quantitative comparison of sediment supply and transport capacity (expressed in tons/day or equivalent) will be analyzed at each site.*

Set survey benchmarks.

Survey bank lines using GPS.

Re-survey twice yearly during study to establish bank erosion rates.

Prepare figures showing bank erosion sites.

10.1.1 Identify Historical Erosion Sites from River Meander History

"Banks with noticeable erosion and banks that have eroded in the past (as identified by comparing the air photos and survey maps) will be catalogued. Ortho-rectify recent aerial photos to use as a base map for plotting bank erosion."

Plot successive bank lines available from existing topographic and photographic data.

10.1.2 Identify Present Bank Erosion Sites

"Identify bank erosion sites using air photos, survey maps, and field inspection."

(In Progress)

10.1.1.1 Herringer Bank Erosion Sites (JEM Farms)

10.1.1.2 Shanghai Bend Bank Erosion Site

10.1.1.3 Nelson Bend Bank Erosion Site

Table 31. Bank Erosion Sites Index

RM	Bank*	Length (feet)	Comment*	RM	Bank*	Length (feet)	Comment*
60.3	left	200	Split flow	41.2	right	1000	Intermittent C/C RUB
59.8	right	700	Split flow	40.6	right	1850	
59.1	left	900	Across river from outlet	40.3	left	1500	
58.9	right	1200	D/S Thermalito afterbay outlet	40.1	right	900	
58.4	right	1200	Split flow TRB right channel	40.0	left	2400	Some ACF
58.4	left	2300	Split flow TRB right channel	39.8	right	1200	Intermittent
58.4	left	3600	Split flow TRB left channel	39.2	left	2800	
57.3	right	600	Split flow	38.8	right	400	
56.9	right	1000		38.0	right	4000	Intermittent Qmod @ Levee
56.6	left	400		37.5	right	1400	Intermittent
56.3	left	1900	Intermittent-tailings	37.2	left	800	
55.8	right	2150		37.0	right	1000	
55.0	left	1900	Modesto	36.5	left	1700	Intermittent
54.5	right	1800	Tailings	36.0	left	2200	
54.5	left	500	Tailings	36.0	right	5500	Intermittent
54.3	right	1000	Tailings	35.6	left	400	
54.0	left	2500		35.2	right	1700	Intermittent-some C/C RUB
53.6	right	800	Intermittent	34.9	left	900	
53.5	left	1500	Intermittent	34.7	right	3050	U/S Limb bendway
52.9	right	500		34.3	left	3400	D/S end tight bendway
52.3	left	1800		33.9	right	1350	Bendway-Qmod @ Levee
51.5	right	3100	U/S bendway-Intermittent	33.7	right	1100	
50.3	right	700	C/C RUB	33.5	left	3700	Intermittent
49.9	right	650	Straight	33.3	right	2600	Intermittent
49.3	right	700		32.7	left	1300	Intermittent
49.0	left	1000	Car bodies\ orchard	32.4	right	500	Intermittent
48.2	right	400	Car bodies\ orchard	32.0	left	2300	Intermittent
47.9	left	400		31.9	right	1600	Intermittent
47.5	right	1600	Intermittent	31.7	left	400	
47.2	right	300	Split Flow	31.4	right	850	
47.2	left	600	Split Flow	31.2	right	1300	Intermittent
46.9	left	700		31.0	left	3250	Intermittent
46.8	left	1400	Intermittent	30.8	right	800	
46.4	left	4500	Some split flow	30.5	right	700	

Table 31. Bank Erosion Sites Index

RM	Bank*	Length (feet)	Comment*
45.7	right	2400	
45.0	left	2200	
44.6	right	500	Intermittent
44.2	right	600	
43.9	left	1100	
43.6	left	1050	Skating on ACF
43.0	right	1300	Intermittent-some C/C RUB
42.2	left	500	Some C/C RUB
41.9	left	3500	Outside bendway
* view is from upstream looking downstream			
D/S	= downstream		
U/S	= upstream		
ACF	= abandoned channel fill		
C/C RUB	= concrete rubble		
Qmod	= Modesto formation		

RM	Bank*	Length (feet)	Comment*
30.5	left	700	
30.1	right	1000	Intermittent
30.0	left	3000	Intermittent
29.7	right	2300	Intermittent
29.5	left	500	Intermittent
29.2	left	1500	
28.9	right	400	
28.3	right	350	Intermittent
* view is from upstream looking downstream			
D/S	= downstream		
U/S	= upstream		
ACF	= abandoned channel fill		
C/C RUB	= concrete rubble		
Qmod	= Modesto formation		

10.1.3 Select Monitoring Sites

(In Progress)

10.1.4 Monument and Survey Erosion Sites

"Set survey benchmarks. Survey bank lines using GPS. Re-survey twice yearly during study to establish bank erosion rates."

This summarizes the surveying work that the Engineering Studies Section performed for the Geology Section along the Feather River in the area of J.E.M. Farms in Butte County. The primary purpose of the surveying for this project was to collect enough data so that the current location of the river bank could be accurately mapped. The land surveying for the bank erosion study in Butte County was a combination of both conventional and real-time-kinematic global positioning system (RTK-GPS) survey techniques.

The surveying work for this project had to be of a nature precise enough to ensure subsequent surveys can be done for remapping and analysis of bank erosion, accretion, avulsion, or reliction. To allow for future surveys to be located on the same horizontal datum, it was decided that the North American Datum of 1983 (NAD83) would be used for horizontal control. To establish coordinates for each point, the projection for the California Coordinate System, Zone 2 (CCS Zone 2 or SPC CA 2), was used. For the vertical datum, the National Geodetic Vertical Datum of 1929 (NGVD29) was used. This is the vertical datum that was used for creation of contour lines on the quad sheets by the United States Geological Survey. For both datums, the units used were survey feet (sft).

The primary control point for this survey is from the National Geodetic Survey (NGS). This point is Designation Honcut, Permanent Identifier (PID) KS1035 (see Attachment 1). This point has first order horizontal accuracy and first order, class II, vertical accuracy. Since the elevation listed on the NGS data sheet shows the elevation for the North American Vertical Datum of 1988 (NAVD88), the program CORPSCON was used to convert the elevation to NGVD29. The point was originally measured as a NGVD29 elevation and then converted by NGS to a NAVD88 elevation using CORPSCON; since the procedure was simply reversed to obtain the NGVD29 elevation used in this survey, there is no loss of accuracy.

The GPS survey instruments used were a Trimble 4000SSI receiver at the primary control point and Trimble 4700 receivers at the rovers. These dual-frequency receivers observe carrier phase satellite measurements on both the L1 and L2 frequencies. The base GPS receiver was equipped with a compact L1/L2 antenna. The rover receivers were equipped with micro-centered L1/L2 antennas. All of the antennas were used with ground-planes to greatly reduce the possibility of multi-path problems. The points set using RTK-GPS were located in areas open to the sky to also reduce the chances of problems with multi-path.

After temporary points were established using RTK-GPS, their relative accuracy was verified using a survey control quality Geodimeter 600 series total station. The measured distance between each temporary point was found to be within 0.15 feet horizontally and 0.10 feet vertically of the calculated distance between each point; the calculated distance being based on the coordinates computed from the RTK-GPS. Using these temporary control points along with other points set using the total station, the bank position was mapped by locating every major change in bank alignment along with dozens of supplemental points located between the major changes.

To ensure that future mapping is comparable to this survey, survey monuments were set some distance away from the current bank location. These monuments are #5 rebar set in concrete with aluminum caps stamped “DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT.” These monuments can be used for control in the future to remap the bank, or can be used as checks if new control is set using GPS or some other method.

10.1.5 Monitor Erosion

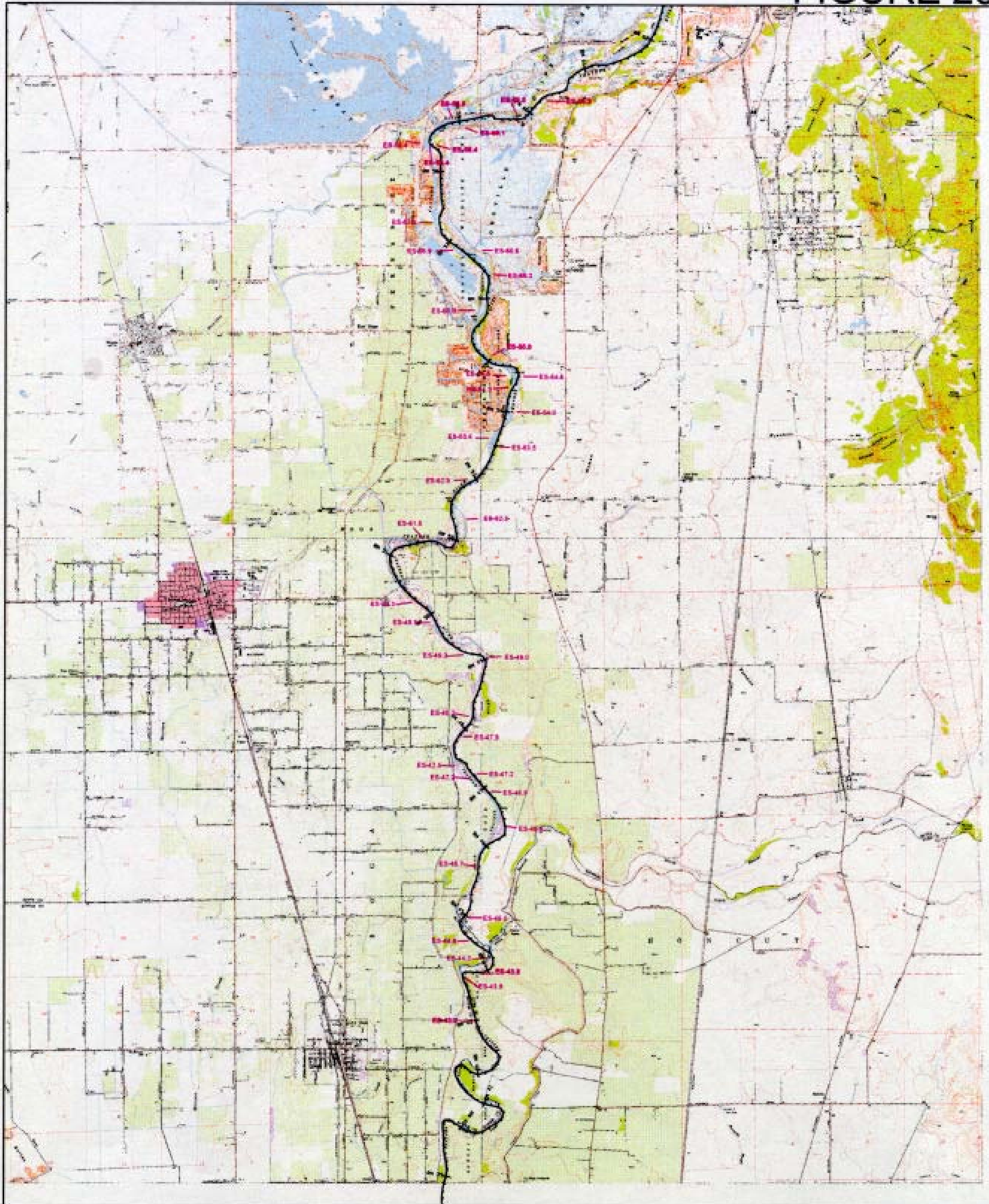
(In Progress)

10.2 ANALYSES

Compare historic bank erosion rates using figures and tables. Insert data into ArcView GIS.”

(In Progress)

FIGURE 28



Feather River
Potential Bank Erosion Monitoring Sites

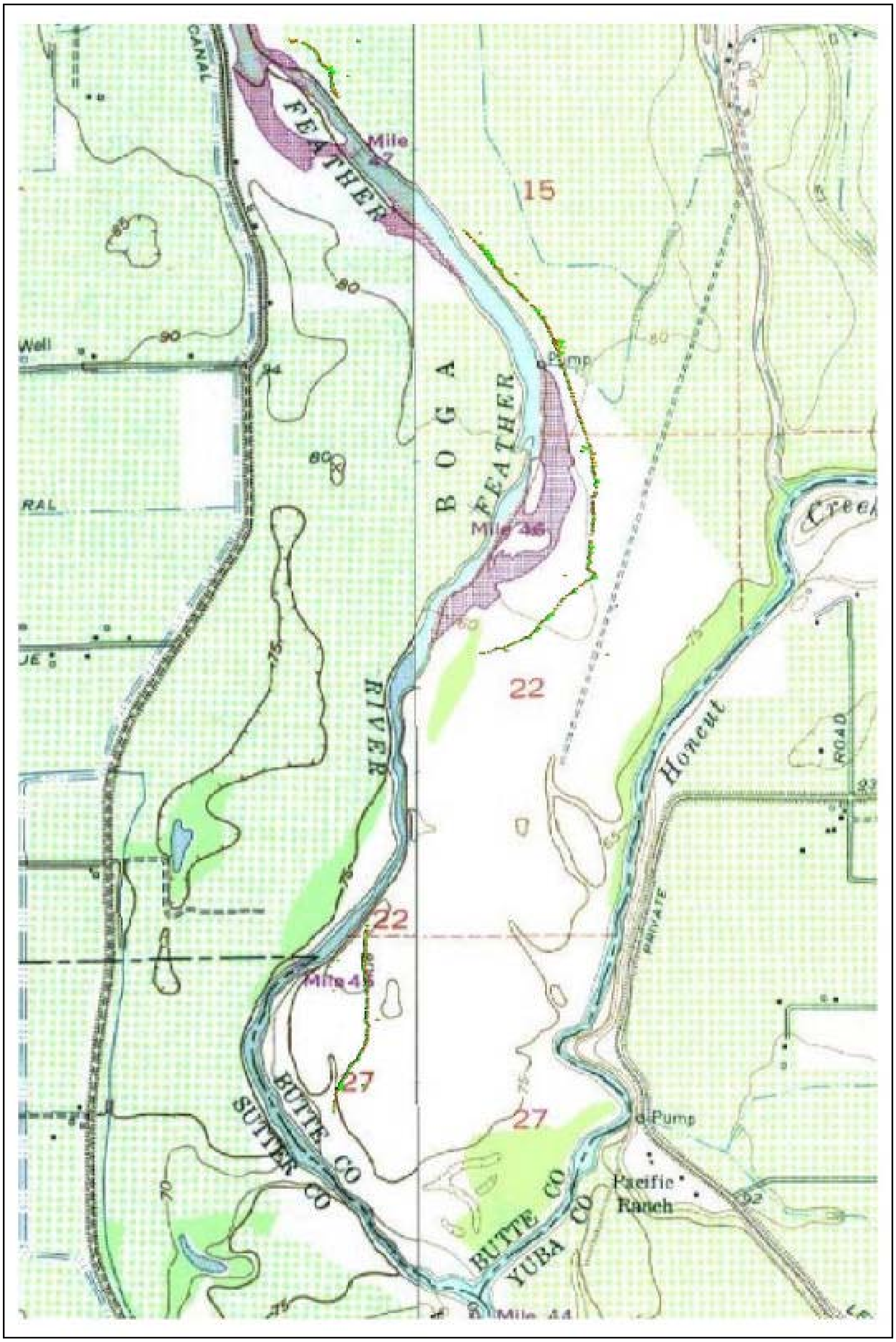
Feet

Filename:N:\RAID1\Geo\PROJECTs\Feather River\0 - Interim Report\Figures\Latest Numbered Figures\Figure 28 - Potentia

Layout Name:Layout4-Layout1 Plot Time: May 09, 2003 - 1:41pm

Oroville FERC Relicensing
(Project No. 2100)

FIGURE 29



Bank Erosion at JEM Farms

100 0 1000
Feet

N

11.0 MODEL SEDIMENT TRANSPORT AND CHANNEL HYDRAULICS

11.1 METHODOLOGY AND RESULTS

"DWR will review the available models and select the model most appropriate for the conditions occurring in the study reach. The selected model will be used to estimate sediment transport parameters and compare existing and potential future channel form and sediment transport function. Model outputs will include changes in channel scour and fill, bedload, roughness, cross-section, gradient, and sediment transport. Hydraulic conditions such as bottom shear stress, velocity, and wetted hydraulic radius will also be model outputs. Several bedload transport equations will be used, in order to identify the one most compatible with the Feather River. A bedload transport curve will be developed from model output data. This will allow the use of "design" flows to move gravel in the system. The curve can also be used to predict when additional gravel needs to be added to the system.

One of the main uses of the model is to determine at which flows the gravel bed begins to mobilize. This is critical in determining flow conditions that degrade spawning riffles. It is also important in designing spawning gravel rehabilitation measures. The model is a useful tool for predicting future changes caused by various hydraulic scenarios.

Model outputs will be calibrated with data from Task 4 and with painted and radio-tagged rocks. These rocks will be placed in the river in a number of selected places, and monitored through the winter season to determine at what flows the rocks begin to move. Rocks will be color-coded according to location. Radio-tagged rocks are first drilled using a rock bit then a small radio transmitter or transponder is inserted, and sealed using epoxy. A radio receiver or oscilloscope will be used periodically to monitor movement after significant flow events have occurred.

The magnitude, timing, duration, rate of change and frequency of flows will be described with hydrographs and exceedance tables. The time-scales will be those allowed by the existing data, daily, monthly, hourly, or in 15-minute increments. A series of tables will also be generated from the streamflow gaging data including: monthly flow statistics tables summarizing mean monthly flow and monthly exceedance flows; tables summarizing average monthly flow; tables summarizing mean daily flow for each year of the period of record; duration curves depicting the median flow for each station.

11.1.1 Sediment Model Selection

"Select most appropriate model(s) from the numerous available

DWR reviewed ____ sediment transport models for appropriateness to this study (DWR, 2002, in-house memorandum).

(In Progress)

11.1.2 Sediment Model Inputs and Assumptions

"Collect data and insert into model."
"Document major assumptions used in the modeling."
Data inputs to the Fluvial 12 model include:

Complete hydrology data sets
Historic and current Cross-section data
Sediment characteristics

Data input tables are detailed in Appendix C.

(In Progress)

Table 32. Fluvial-12 Sediment Transport Model Input Data Requirements

(In Progress)

Table 32. Data Input Requirements for the Fluvial-12 Sediment Transport Model

MODEL INPUTS	1901 - 1965 DATA SETS: Low Flow Reach, RM 67 (Hatchery) to RM 59 (Thermalito)	1901 - 1965 DATA SETS: High Flow Reach, RM 45 (Honcut Creek) to RM 59 (Thermalito)	1965 - 1996 DATA SETS: Low Flow (Hatchery to Thermalito)	1965 - 1996 DATA SETS: High Flow (Thermalito to Honcut Creek)	1997 - 2002 DATA SETS: Low Flow (Hatchery to Thermalito)	1997 - 2002 DATA SETS: High Flow (Thermalito to Honcut Creek)	COMMENTS
DISCHARGE RECORDS							
Daily Flow Records	CDEC hourly flow data for gaging station # 11407000 (at diversion dam); 1901-1965	CDEC hourly flow data for gaging station # 11407000 (at diversion dam); 1901-1965 (both reaches have same flow)	CDEC hourly flow data for gaging station # 11407000 (at diversion dam); 1966-1996	CDEC hourly flow data for gaging station #11407150 (at Gridley Bridge) 1964-1996	CDEC hourly flow data for gaging station # 11407000 (at diversion dam); 1997-2002	CDEC hourly flow data for gaging station #11407150 (at Gridley Bridge) 1997-1998;	
Stage records	CDEC hourly stage data for gaging station # 11407000 (at diversion dam); 1901-1965	CDEC hourly stage data for gaging station # 11407000 (at diversion dam); 1901-1965 (both reaches have same stage)	CDEC hourly stage data for gaging station # 11407000 (at diversion dam); 1966-1996	CDEC hourly stage data for gaging station #11407150 (at Gridley Bridge) 1964-1996	CDEC hourly stage data for gaging station # 11407000 (at diversion dam); 1997-2002	CDEC hourly stage data for gaging station #11407150 (at Gridley Bridge) 1997-1998;	
Flood Hydrograph Records	MWH Global is generating HEC-2 compatible hydrographs for all events > 5000 cfs	MWH Global is generating HEC-2 compatible hydrographs for all events > 5000 cfs	MWH Global is generating HEC-2 compatible hydrographs for all events > 5000 cfs	MWH Global is generating HEC-2 compatible hydrographs for all events > 5000 cfs	MWH Global is generating HEC-2 compatible hydrographs for all events > 5000 cfs	MWH Global is generating HEC-2 compatible hydrographs for all events > 5000 cfs	Datasets for 1965-2002 hydrographs for the low flow reach have been completed and checked by Howard Chang.
Water Temperature	ND-Water Quality data?	ND-Water Quality data?	DWR 1970 report "Lower Feather River Water Quality"; also DFG's 1979 report - "Temperatures on the Feather River at Oroville"	DWR 1970 report "Lower Feather River Water Quality"	ND-Water Quality data (sampling stations #'s 21-27)	ND-Water Quality data (sampling stations #'s 27-32, 42)	
CROSS-SECTIONS AND PROFILES							
Topography of channel and floodplain (cross-sections)	Army Debris Commission 1909 2-foot contour map. 23 cross-sections across flood-plain (soundings in channel).	Army Debris Commission 1909 2-foot contour map. 15 cross-sections across flood-plain (soundings in channel).	DWR 1965 5-foot contour map (EXCEPT for underwater!!). 15 cross-sections across floodplain (with soundings in channel) replicate 1909 work. Also 1971 USGS cross-sections (71); 1982 DWR cross-sections (about 100?)	DWR 1965 5-foot contour map (EXCEPT for underwater!!). 15 cross-sections across floodplain (with soundings in channel) replicate 1909 work. Also 1971 USGS cross-sections (71); 1982 DWR cross-sections (about 100?)	USACE 1997 2-foot contour map. 46 UNET cross-sections across floodplain (bathymetry in channel).	USACE 1997 2-foot contour map. 125 UNET cross-sections across floodplain (bathymetry in channel).	
Profile and slope of the channel	1909 longitudinal thalweg profile; historic USGS topos (at State Library)	1909 longitudinal thalweg profile; historic USGS topos (at State Library)	1965 longitudinal thalweg profile; USGS topos	1965 longitudinal thalweg profile; USGS topos	USACE 1997 2-foot contour map.	USACE 1997 2-foot contour map.	
BED MATERIAL DATA							
Bulk sample data (size fractions)	Gravel operations? Dredging piles? Upriver samples?	Gravel operations? Dredging piles? Upriver samples?	DWR: 1982 = 10 samples; 1996 = 10 samples; also USGS sampling	DWR: 1982 = 10 samples; 1996 = 10 samples; also USGS sampling	In progress.	In progress.	ND-Geology staff is currently repeating the 1982 and 1996 bulk sampling. This will be supplemented with additional sampling at cross sections where required for the modeling.
GEOMORPHIC DATA							
Bank Erodibility	geologic map; changes in historic channel center-lines	geologic map; changes in historic channel center-lines	geologic map; changes in historic channel center-lines	geologic map; changes in historic channel center-lines	geologic map; field evaluation	geologic map; field evaluation	Available from 1901 through 1981 in the DWR report "Feather River Spawning Gravel Baseline Study"
Bank Protection	Army Debris Commission 1909 2-foot contour map.	Army Debris Commission 1909 2-foot contour map.	DWR 1965 5-foot contour map.	DWR 1965 5-foot contour map.	USACE 1997 aerial photography	USACE 1997 aerial photography	
Immobile Bed Areas	geologic map	geologic map	geologic map	geologic map	geologic map	geologic map	
Bed Surface Composition	??	??	DWR: 1982 = 42 samples; 1996 = 10 samples	DWR: 1982 = 106 samples; 1996 = 10 samples	In progress.	In progress.	ND-Geology staff is currently repeating the 1982 and 1996 Wolman sampling. This will be supplemented with additional sampling at cross sections where required for the modeling.
Thickness of Erodible Bed Layer	DWR well and auger data; 1909 longitudinal profile of thalweg	DWR well and auger data; 1909 longitudinal profile of thalweg	DWR well and auger data; 1965 longitudinal profile of thalweg	DWR well and auger data; 1965 longitudinal profile of thalweg	DWR well and auger data; 1997 longitudinal profile of thalweg	DWR well and auger data; 1997 longitudinal profile of thalweg	1909 thalweg profile completed.
Specific Gravity	samples	samples	samples	samples	samples	samples	
Radius of Curvature of Bends	Army Debris Commission 1909 2-foot contour map.	Army Debris Commission 1909 2-foot contour map.	DWR 1965 5-foot contour map.	DWR 1965 5-foot contour map.	USACE 1997 2-foot contour map.	USACE 1997 2-foot contour map.	
CHANNEL AND OVERBANK ROUGHNESS							
Manning's Coefficient of Roughness	aerial photos	aerial photos	aerial photos; gravel sample analysis	aerial photos; gravel sample analysis	aerial photos; gravel sample analysis; site review	aerial photos; gravel sample analysis; site review	

11.1.3 Sediment Model Calibration

"Calibrate model using sediment and hydraulic monitoring data collected under Task 4."

(In Progress)

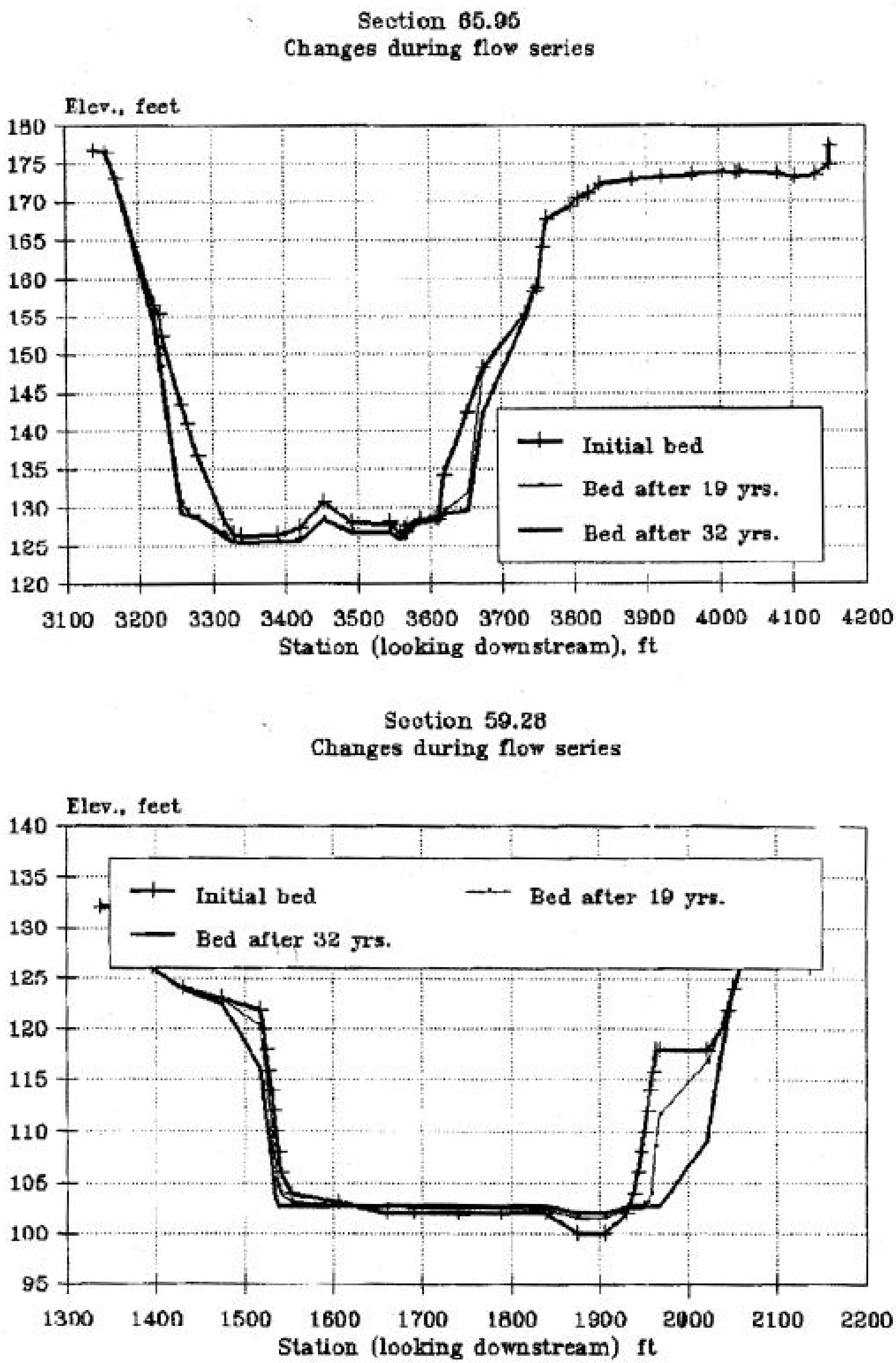
11.1.2 Sediment Model Outputs

"Run model to determine future changes. Conduct hydraulic simulations to determine initial gravel bed motion, sediment transport rates, channel changes (aggradation or degradation), slope change, bed armoring, etc.

The study will be used to identify the hydraulic, geomorphic, and sediment transport changes that have occurred. The effect of these changes on salmonid spawning riffles, flooding, riparian vegetation, riparian habitat, and river habitat will be assessed. Changes in sediment transport will be evaluated for various proposed flow regimes. Based on the results of the study, we will identify needs for protection, mitigation or enhancement activities. The study results will also be used by other studies to help assess the project's ongoing effects on downstream water quality, aquatic and riparian resources, and protection of private lands and public trust resources.

Run model to determine future changes. Conduct hydraulic simulations to determine initial gravel bed motion, sediment transport rates, channel changes (aggradation or degradation), slope change, bed armoring, etc.

11.2 ANALYSES

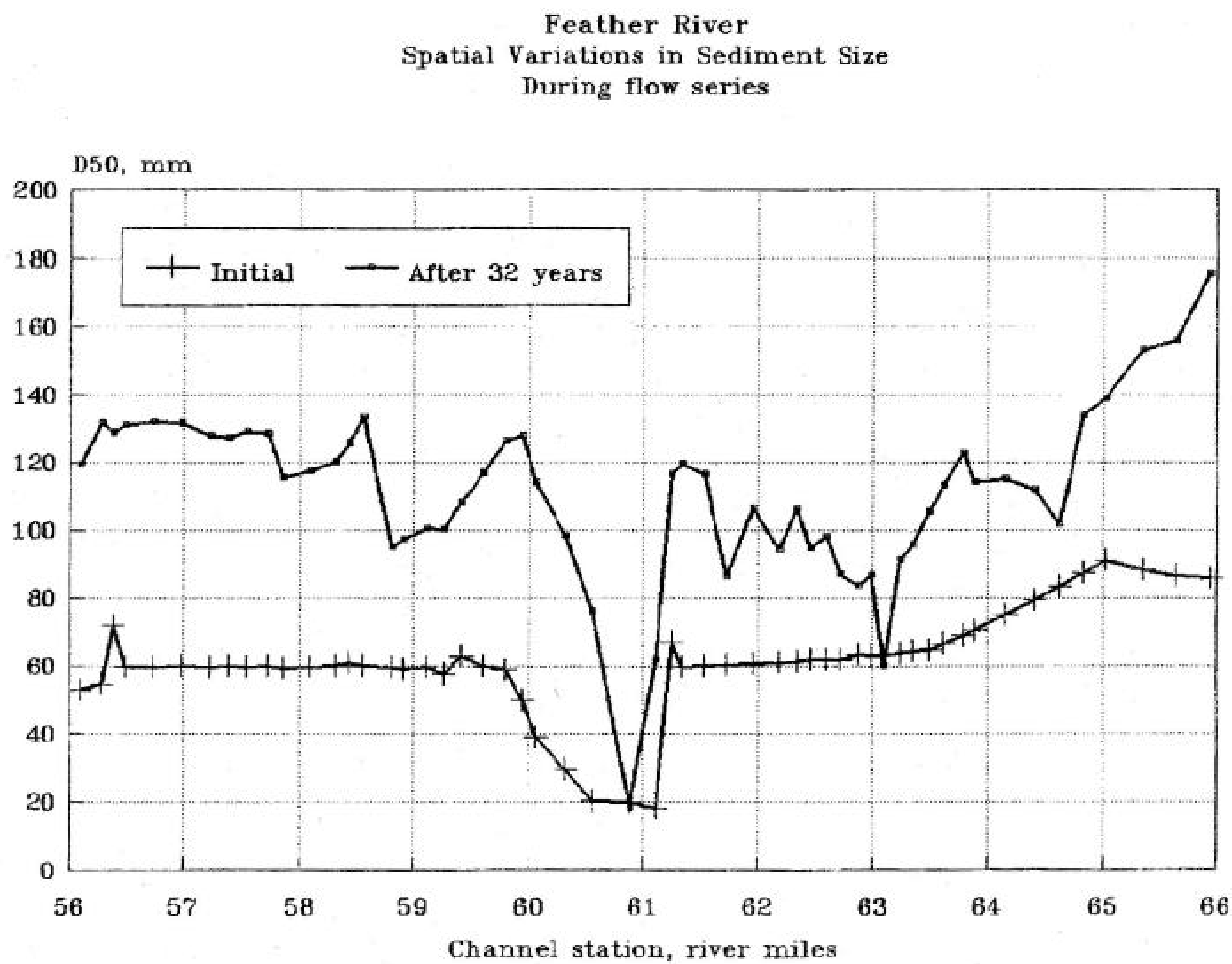


SP-G2 FEATHER RIVER GEOMORPHIC STUDY

FLUVIAL-12 MODEL OUTPUT EXAMPLE

PROJECTED CHANNEL CHANGES AT RM 59.28 AND 65.95

FIGURE 31



SP-G2 FEATHER RIVER GEOMORPHIC STUDY

FLUVIAL-12 MODEL OUTPUT EXAMPLE

PROJECTED SEDIMENT CHANGES FROM RM 56 TO RM 66

Filename:N:\RAID1\Geo\PROJECTs\Feather River\0 - Interim Report\Figures\Latest Numbered Figures \Figure 31 5-8-03 ca.dwg
Layout Name:Layout3-Layout1 Plot Time: May 20, 2003 - 8:57am

Oroville FERC Relicensing
(Project No. 2100)

12.0 REFERENCES AND BIBLIOGRAPHY

12.1 REFERENCES

"Andrews, E. D. and J. M. Nankervis. 1995. Effective discharge and the design of channel maintenance flow for Gravel-bed Rivers. In: Natural and Anthropogenic Influences in Fluvial Morphology, American Geophysical Union, and Geophysical Monograph 89.

California Department of Water Resources (Delta Branch), *Establishment of Feather River Channel Characteristics*, 1965.

California Department of Water Resources (Northern District), *Feather River Spawning Gravel Baseline Study*, 1982.

Hill, M. T. and, W. S. Platts, R. L. Beschta. 1991. Ecological and Geomorphological Concepts for Instream and Out-of-Channel Flow Requirements. Rivers. 210, Volume 2, Number 1.

Richter B. D., Baumgartner J.V., Powell J., and Braun D.P., 1996. A method for assessing hydrologic alteration within ecosystems. Conservation Biology, 10, 1163-1174.

Rosgen, D. L. and H. L. Silvey. 1996. Applied River Morphology. Wildland adobeHydrology. Pagosa Springs, CO. Printed Media Companies. Minneapolis, Minnesota.

U.S. Geological Survey, *Sediment Transport in the Feather River, Lake Oroville to Yuba City, California*, 1978."

12.2 BIBLIOGRAPHY